UNIT 10: FORAGING BEHAVIOR

Animals must obtain food from the environment in order to provide the energy necessary for growth, maintenance and reproduction. Foods vary in nutritional content and securing food comes with costs. Energy is expended while searching for, capturing and processing prey. Potential injury by prey or capture by a larger predator are risks encountered during foraging. Foraging involves the tradeoff between these costs and benefits. Natural selection will favor animals that can maximize the benefit while minimizing expense of food gathering.

Acquiring food is rarely a simple process. Few species enjoy the luxury of a quick trip to a fast food restaurant to satisfy hunger. For food gatherers to be successful they have to identify, locate, and ingest suitable prey. While it may sound relatively simple, this is not often an easy task. If an animal preys on other animals it must identify, hunt, capture and subdue prey that is desperately trying to escape detection and elude capture. Since plants are immobile, herbivores might seem to have a simpler job; however, they also encounter difficulties in locating and identifying suitable plant species, often in a patchy environment.

No animal is perfectly adapted; however, the evolutionary history of each species has crafted many structural and physiological adaptations that aid in the acquisition of food. In addition to morphological and physiological specializations, many animals also employ specific, often complex behaviors that increase feeding efficiency. These behaviors, like other phenotypic traits, are heritable characteristics that form one part of the forager's arsenal.

In this laboratory unit we will concentrate on the behavioral aspects of foraging. A forager must have the proper sensory tools and intelligence, in this case the ability to follow directions and learn from experience, to be successful. Our simulation will involve foragers locating specific prey "bean" species within a confined environment. We will examine different foraging modes, different prey densities, and effect of competition and specialization on the success of our foragers.

Group supplies: bucket containing approximately 10 pounds of rice, an assortment of different types of beans, hand strainer, stopwatch, marker and a die.

Exercise 1. Single Prey Species

For this exercise group members will take turns foraging. One member will serve as recorder/time keeper of the data. The forager must find three kidney beans within 10 seconds or die of starvation (indicated by an "x" in the elapsed time column. Foragers can only use one hand and must not remove substrate from the bucket. When the forager captures a "prey" item they must free it from the substrate, hold it up and say "found one" to simulate handling time and place it in the designated cup. Beans placed in the cup along with rice will not be counted. The recorder will keep time, verify that beans are free of any substrate and record the elapsed time required to find the three beans in Table 10.1. At the end of each foraging period the recorder will hide any exposed beans and smooth the surface for the next trial.

To begin the exercise the recorder/time keeper will hide 30 red kidney beans in the bucket of rice. Foragers are not permitted to watch this process. Once the beans are hidden in

the substrate and the surfaced smoothed, the first trial can begin. During each foraging period only the current forager and recorder are permitted to watch. The forager will then serve as recorder/time keeper for the next foraging period and the recorder enters the rotation as the final forager. Continue this rotation until all members of the group have died. Remove any remaining beans by sifting the rice into an empty bucket at the end of the exercise.

Table 10.1

Foraging Period	Forager	Elapsed Time (sec)	Beans Remaining
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

Were all of the prey items collected before all of the foragers died? What could prey do to reduce the likelihood of falling victim to a predator? How might a predator respond to a depleted food source?

Exercise 2: Multiple Prey Species

The first exercise represents a situation where a predator specializes on a single prey type or group of closely related prey types. Koala feed on leaves of the eucalyptus trees. Closer to home, hognose snakes (*Heterodon* sp.) throughout Missouri feed almost exclusively on toads of the genus *Anaxyrus*. These are examples of foragers that are dietary **specialists**.

Great Blue Herons, on the other hand, are opportunistic feeders that use their sharp, stabbing bills to capture and consume a variety of prey types. Food items recorded for herons include: fish, frogs, salamanders, snakes, turtles, small mammals and birds, crayfish, crab, insects, shellfish and even human scraps. Predators such as herons are dietary **generalists**.

To simulate a natural situation we will repeat the sampling procedure with a variety of prey items. Prey types can be easily identified by color, size, shape and surface texture so forager may uses visual and tactile cues to locate prey. Each member of the group will pick a specific type of prey and forage exclusively for that type. Since there are typically four members to each group and only three prey types, some foragers will be competing for the same prey. If there are only three members in your group, eliminate one of the bean types.

To begin, have the recorder place 30 lima beans, 30 pinto beans and 30 great northern beans in the bucket and distribute them through out the substrate. Each forager must find three individuals of the correct prey within 10 seconds to survive to the next rotation. The recorder will keep time, verify that the collected prey is clean and the correct type when placed in the cup and record the results in Table 10.2. At the end of the foraging period, the recorder will hide any exposed beans and smooth the surface before the next forager takes their turn. Continue the rotations until all members of the group have starved.

Did your foraging efficiency increase with experience? Do other prey types get in the way of specialists?

Table 10.2 Dietary specialist with equal prey densities

Foraging Period	Forager	Time to captured 3 lima beans	Time to captured 3 pinto beans	Time to captured 3 great northern beans	Remaining lima beans	Remaining pinto beans	Remaining great northern beans
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							
17							
18							
19							

In the next portion of the exercise we will introduce generalist foragers into the system. To determine your foraging mode each member of the group will roll the die. If the number you roll is odd you will remain a specialist. If you get an even number you will become a generalist. Specialist will get to choose their prey and will also go first in the rotation. Once three specialists have been selected, the fourth member will be a generalist. At least one member should remain a specialist.

To begin, the last person in the rotation (a generalist) will redistribute and hide the beans in the bucket. Each forager must find three beans of the correct type within 10 seconds to continue to the next rotation. Continue until all members have starved. At the end of this portion of the exercise sift the rice to remove any remaining beans. Record your data in Table 10.3.

Table 10.3 Different foraging modes with equal prey densities

Foraging Period	Forager (mode)	Time to captured 3 lima beans	Time to captured 3 pinto beans	Time to captured 3 great northern beans	Remaining lima beans	Remaining pinto beans	Remaining great northern beans
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							
17							
18							
19							

In the final portion of the exercise we will again use multiple prey types, but each prey "species" differs in size, abundance and caloric value from other types. To survive and progress to the next rotation, each forager must collect the equivalent of 50 caloric points within the foraging period. Three types of prey will be available: Lima beans (10 pts each), Pinto beans (15 pts) and Great Northern beans (20 pts).

Table 10.4 Different foraging modes with variable prey densities

Foraging Period	Forager (mode)	Captured lima beans	Captured pinto beans	Captured great northern beans	Total points	Elapsed time (sec)	Remaining lima beans	Remaining pinto beans	Remaining great northern beans
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									

To determine dietary mode, each member of the group will again roll the die. If the number is odd, the forager will be a specialist. Even numbers will be generalists. Specialist will pick their prey bean species and get to forage first.

Begin the exercise by having the recorder distribute 40 lima beans, 30 pinto beans and 20 great northern beans in the rice substrate and smooth the surface. Each forager will have 10 seconds to capture a minimum of 50 points worth of prey and place them in the cup in order to survive to the next round. Foragers should decide on a foraging strategy before sampling. The time keeper/recorders will record the results in Table 10.4. Continue the rotation until all of the foragers have died. Summarize the class data below in Table 10.5.

How did you select your prey? Compare strategies with members of your group. Did all members of your group employ the same strategy?

Table 10.5 Summary of foraging data with multiple prey types

Specialist with equal prey densities			Different foraging modes with variable prey densities					
Forager	Competition (Y/N)	Number of foraging events	Foraging mode	Low prey density	Medium prey density	High prey density	Number of Competing generalists	Number of foraging events
1			Spec 1					
2			Spec 2					
3			Spec 3					
4			Spec 4					
5			Spec 5					
6			Spec 6					
7			Spec 7					
8			Spec 8					
9			Spec 9					
10			Spec 10					
11			Spec 11					
12			Spec 12					
13			Spec 13					
14			Spec 14					
15			Spec 15					
16			Gen 1					
17			Gen 2					
18			Gen 3					
19			Gen 4					
20			Gen 5					
21			Gen 6					
22			Gen 7					
23			Gen 8					
24			Gen 9					
			Gen 10					
			Gen 11					
			Gen 12					
			Gen 13					
			Gen 14					
			Gen 15					

Exercise 3: Adaptation and specialization.

Many species have adaptations that allow them to exploit a food source more efficiently or to exploit one that is unavailable to other foragers. In our earlier simulations, prey has been the passive victim of our predation. In the real world things are very different. Prey can flee, or limit their movement, activity periods, or rely on camouflage to remain less conspicuous. They may use spines, thorns and other ornamentation so that they are difficult to manipulate and consume. Many fungi, plants and animals concentrate noxious or toxic substances in their tissues that make them unpalatable or lethal to predators.

In this exercise you will again use 40 lima beans, 30 pinto beans and 20 great northern beans. Caloric values will also remain the same as the last exercise (10 cal/lima bean, 15 cal/pinto bean and 20 cal/great northern bean); however, this time you will use the marker to place a spot on 10 of the great northern beans to indicate that they are toxic. A forager that consumes one of these beans by placing it in the container without being able to denature the toxin will immediately die. Each member of the group will roll the die to determine which specialization they will have. Rolling a one or two increases foraging efficiency (15 sec foraging periods), three will be immune to the toxin, and four will have a greater digestive efficiency (15 cal/lima bean). Foragers rolling a five or six will remain unspecialized. Foragers must still obtain 50 points within 10 seconds to survive to the next rotation. Any forager can voluntarily reject a toxic bean after visual examination by replacing it in the bucket; however, once a bean has been placed in the cup it must be counted. Record the results in Table 10.6 and summarize class data in Table 10.7.

At the end of the rotations, sift the rice to remove any remaining beans. Discard any broken or marked beans. Separate and return the other beans to the appropriate containers.

Trial	Forager (type)	Specialization	Captured lima beans	Captured pinto beans	Captured great northern beans	Captured toxic beans	Total points	Elapsed time (sec)	Remaining lima beans	Remaining pinto beans	Remaining great northern beans
1											
2											
3											
4											
5											
6											
7											
8											
9											
10											
11											
12											
13											
14											
15											
16											

Table 10.7 Summary of foragers with specializations and variable prey densities

Forager (type)	Specialization	Low prey density	Medium prey density	High prey density	Number of competing generalists	Number of foraging events
1						
2						
3						
4						
5						
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7						
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23						
24						

Name _____
GTA _____
Date _____

LAB SESSION 10: WORKSHEET

1. Did specialists do better as foragers in your simulations? What is an advantage to being a specialist? What is a disadvantage of being a specialist? (3 pts)

2. What is an advantage of being a generalist? What is a disadvantage to being a generalist? (2 pts)

3. What effect, if any, was observed when competition for a prey type occurred. How do your data support your conclusion? Is this the result you expected? Why? (3 pts)

4. Did the presence of toxic prey in the population modify your foraging strategy? If so, how? (2 pts)

Name _____
GTA _____
Date _____

LAB SESSION 10: WORKSHEET

5. Food resources are rarely distributed uniformly in the environment. Most vary seasonally or have a patchy distribution and can become locally depleted. Give two possible responses of an animal species to depleted food resources in the real world. Explain how they work to solve the problem of limited prey and give an example of an animal species that employs each strategy. (6 pts)

6. As the polar ice shrinks with rising global temperatures, brown bears are expanding their range into the historical distribution of their close relative, the polar bear. Could this shift be explained by foraging strategy? If so, how? (4 pts)